DEPARTMENT OF THE NAVY
BUREAU OF MEDICINE AND SURGERY
WASHINGTON, D.C. 20372

IN REPLY REFER TO
NAVMED P-5055 CH-3
BUMED-532
23 November 1976

NAVMED P-5055 CHANGE TRANSMITTAL 3

From: Chief, Bureau of Medicine and Surgery
To: All Ships and Stations Having Medical/Dental Personnel

Subj: Radiation Health Protection Manual (NAVMED P-5055); advance change to

Encl: (1) Advance Change No. 3; NAVMED P-5055; (Chapter 6)
(2) Thermoluminescent Dosimetry Audit Procedures

1. Purpose. To effect an advance change to the subject publication for revision of the personnel dosimetry requirements for radiographers and radiographers' assistants and for implementation of the Lithium Fluoride Thermoluminescent Dosimetry Program.

2. Discussion.

a. Effective 4 August 1976, a new rule promulgated in the U.S. Code of Federal Regulations (10CFR 34.33) permits radiographers and radiographers' assistants to utilize thermoluminescent dosimeters in the performance of their work. Enclosure (1) incorporates this new rule in Article 6-1 of the NAVMED P-5055 as a revision of the personnel dosimetry requirements for these occupations.

b. Change 1 to the NAVMED P-5055 set forth personnel dosimetry requirements in which thermoluminescent dosimetry was to replace photodosimetry on an organization by organization basis as equipment became available. This is being accomplished, with the approval of BUMED, in accordance with NAVSEA radiological control manuals for ships and stations associated with the Naval Nuclear Propulsion Program utilizing the Calcium Fluoride Thermoluminescent Dosimetry System.

c. The Lithium Fluoride Thermoluminescent Dosimetry Program as described in Article 6-4 of enclosure (1) is being implemented as a dosimetry service by BUMED to replace photodosimetry and calcium fluoride thermoluminescent dosimetry where there is a requirement for monitoring personnel for administrative reasons only or those exposed to gamma and/or neutron radiation. Personnel exposed to x-radiation from

x-ray devices operated at less than 250 KVP will continue to utilize photodosimetry.

d. Lithium fluoride thermoluminescent dosimetry will be provided to organizations on an individual basis via letter requests to BUMED. Replacement of calcium fluoride thermoluminescent dosimetry and photodosimetry with lithium fluoride thermoluminescent dosimetry in ships and stations associated with the Naval Nuclear Propulsion Program will be accomplished in accordance with NAVSEA directives with the approval of BUMED.

e. The Medical Department retains the responsibility for ensuring proper performance of all dosimetry and overall administration of radiation health programs. This shall include auditing the performance of thermoluminescent dosimetry according to the recommended procedures contained in enclosure (2).

3. Action.

a. Enclosure (1) contains revisions to Articles 6-1 and 6-4 of subject manual and is effective upon receipt of this notice. Remove Articles 6-1 and 6-4 from the basic manual and insert the pages of enclosure (1).

b. Enclosure (2) is a revision of the Thermoluminescent Dosimetry Audit Procedures. Replace current audit procedures with enclosure (2).

c. Make the following pen and ink change throughout the manual:

(1). Change Code 74 to Code 53

d. For entries in columns 9 through 12 of the Record of Occupational Exposure to Ionizing Radiation, DD-1141, the method of monitoring is presumed to be film badge or thermoluminescent dosimetry unless otherwise specified under item 16. No remark is necessary in item 16 when either film badge or thermoluminescent dosimetry is the method of monitoring.

4. Cancellation. When the required action has been taken and the change entered in the record of changes.

W. P. ARENTZEN

ADVANCE CHANGE NO. 3

Radiation Health Protection Manual
NAVMED P-5055
Chapter 6

Personnel Dosimetry

6-1. RESPONSIBILITIES

Personnel dosimetry is a technique for detecting and measuring an individual's exposure to ionizing radiation. The Bureau of Medicine and Surgery requires appropriate naval activities to maintain a dosimetry program for personnel who may be occupationally exposed to ionizing radiation. Personnel dosimetry is practiced in order to document an individual's exposure to determine if an individual has exceeded radiation exposure limits, and to aid in minimizing exposure. Personnel dosimetry has both medical and legal significance and must be conscientiously practiced by trained personnel under competent supervision.

(1) Command Responsibility. - The commanding officer of any activity where occupational radiation exposures are incurred shall insure that appropriate personnel dosimetric devices are supplied and shall require the use of such devices; (1) by all personnel who are likely to exceed 300 mrem per calendar quarter, (2) by all personnel entering a high radiation area (i.e., an area where exposure rate is greater than 100 mrem/hour), and (3) by all other personnel as deemed necessary. The type of dosimetric device or devices used to produce the legal personnel exposure record shall be specified by the commanding officer and approved by Chief, BUMED. All radiographers and radiographers' assistants as defined in Title 10, Part 34 of the U.S. Code of Federal Regulations, shall wear a self-indicating dosimeter and either a film badge or a thermoluminescent dosimeter. Radiographers working with x-ray units operated at peak kilovoltage potentials of less than 250 KVP shall wear a film badge. Radiographers working with x-ray units operated at peak kilovoltage potentials of 250 KVP or greater may wear either a film badge or thermoluminescent dosimeter. Commanding officers shall be guided by applicable instructions stipulating the choice of dosimetric devices issued by various commands.

(2) Individual Responsibility. - When a personnel dosimetric device is required, it shall be worn at all times in any area where a radiation exposure may occur. The individual is responsible for loss of, or damage to such a device while in his possession. At the end of the working period, the dosimetric device shall be placed in a low background area.

6-2. DOSIMETRIC DEVICES

Acceptable dosimetric devices include: (1) film badges,

military or civilian personnel are exposed to ionizing radiation shall maintain a Radiation Health Protection Program. Unless other types of dosimetry are approved by BUMED, the dosimetry program shall be based on photodosimetry and its establishment shall be under the cognizance of the senior medical representative present. Organizations associated with the Naval Nuclear Propulsion Program perform dosimetry in accordance with NAVSHIPS 389-0153 "Radiological Controls" or NAVSHIPS 389-0288 "Radiological Controls for Shipyards". All dosimetry evaluations and documentation are the responsibility of the Medical Department and shall be supervised by the Radiation Health Officer or his assigned equivalent. In all cases the dosimetry program will be adequate to meet the requirements of paragraph 6-1(1).

(1) Major Dosimetry Activities. - Major dosimetry activities are Naval Research Laboratories utilizing radiation producing equipment or source materials. Organizations so designated shall include on their radiation protection staff, persons well trained in all aspects of dosimetry used. They shall have processing equipment, measuring devices, and calibration sources appropriate to the execution of a complete high quality personnel monitoring program.

(2) Special Dosimetry Activities. - These activities have particular requirements determined by BUMED and may deal with high radiation intensities or require immediate evaluations of personnel exposure. Therefore, trained technicians and/or supervisors along with necessary equipment are required, and shall be provided to evaluate up to a few hundred dosimetric devices per month. Additional technical assistance will be provided these activities by BUMED, Code 53.

(3) All Other Activities. - Many naval facilities requiring a photodosimetry program will not be categorized as either a major or special dosimetry activity. Such activities utilize a comparatively small number of dosimeters per month and will have little need for on-the-spot exposure evaluations. These activities shall, nevertheless, maintain a Radiation Protection Program. The dosimetry program must be adequate to provide the issuing of dosimetric devices and the recording and reporting of occupational exposures.

(4) Dosimetry Center. - In the course of administering the Navy's Dosimetry Program, BUMED has observed that cost

reductions in equipment, manpower, and related training, as well as greater accuracy in exposure evaluation, can be achieved by performing dosimetry processing at a minimum number of organizations. To this end, one or more dosimetry centers will be maintained under BUMED management control. Such a center shall function to give dosimetry services to all activities not having dosimetry processing capabilities, as well as to serve the Navy's dosimetry program in aspects of research and technology. The Radiological Safety Service, National Naval Medical Center, Bethesda, Maryland 20014, is designated as a dosimetry center. Requests for dosimetry services shall be made to BUMED, Code 53.

6-4. LITHIUM FLUORIDE THERMOLUMINESCENT DOSIMETRY PROGRAM

(1) Discussion. Activities using LiF thermoluminescent dosimeters shall designate their medical department representative the responsibility for administration and maintenance of the program in accordance with this directive. If commands do not have a medical department representative, the local assignement of personnel responsible for the program shall be at the discretion of the commander. The dosimeter used is the lithium fluoride thermoluminescent dosimeter (DT 583), also referred to as the LiF TLD. The LiF TLD is capable of detecting gamma, x-ray, and neutron radiation. The LiF TLD may be issued to monitor personnel for gamma and/or neutron radiation and x-radiation from x-ray devices operated at 250 KVP potential or greater. Other uses are not authorized without approval of the Bureau of Medicine and Surgery. The LiF TLD contains two lithium fluoride chips (see figure 1). Chip number one has been enriched with lithium six which will respond to gamma radiation and thermal neutron radiation. Chip number two has been enriched with lithium seven which will only respond to gamma radiation. The amount of gamma radiation to which the LiF TLD has been exposed is determined directly by reading chip number two. When neutrons enter the body, a percentage of them are thermalized and reflected out of the body. The number of thermalized neutrons reflected is proportional to the number and dependent on the energy of the neutrons entering the body. When the LiF TLD, in its holder, (see figure 2), is worn next to the body, the lithium six chip will detect reflected thermal neutrons. The cadmium filter is placed in front of the LiF TLD to capture thermal neutrons incident to the front of the dosimeter. The difference between the readings of chip number two (gamma dose) and chip number one (gamma plus neutron dose) is used to determine the neutron dose to the body. The range of the LiF TLD is 00.005 to 1 x 10^5 rem for gamma radiation and 00.030 to 1 x 10^5 rem for neutron radiation.

(2) Initiation of the program. Requests for initiation of the Lithium Fluoride Thermoluminescent Dosimetry Program are to be made to the Chief, Bureau of Medicine and Surgery, (Code 53) Navy Department, Washington, D.C. 20372. Fleet activities shall send requests via their type commander. The request shall indicate the number of personnel and areas to be monitored and the type of radiation to be monitored. The LiF TLDs in their holders will be shipped, as a group, along with a supply of forms, Thermoluminescent Dosimetry Evaluation, (NAVMED 6470/3), directly to the requesting command. Dosimeters from different groups shall not be mixed (see paragraph (3)(c)).

(3) Personnel Dosimetry. Neutron and gamma radiation monitoring shall be accomplished in the following manner:

(a) Issue

1. When issuing the LiF TLD, the five digit number on the front of the holder shall be used to identify the dosimeter. This number shall be transcribed next to the individual's name on the NAVMED 6470/3.

2. Issue periods shall he as follows:

a. The issue period for all personnel utilizing the LiF dosimeter will be 60 days, not to exceed 90 days, except for: (1) occupational radiation workers and personnel monitored for administrative reasons who are assigned to SSBNs for which the issue period will be for the duration of the patrol cycle. (2) for occupational radiation workers and personnel monitored for administrative reasons who are assigned to SSNs the issue period will be directed by BUMED in consultation with type commanders.

b. Posted TLDs for the same issue period as that used for personnel.

c. If operational commitments do not allow dosimeters to be mailed for evaluation at the end of their issue period, they may be retained onboard until mailing is possible. Dosimeters shall not be kept for more than 150 days without the permission of BUMED.

3. If it is suspected that an exposure limit has been exceeded, the LiF TLD shall be submitted for evaluation as soon as possible.

(b) Wearing of the Dosimeter. The individual receiving the dosimeter shall be instructed to wear it at waist level on the front of the body, using the belt loop, so that the back of the holder remains against the body at all times. If, during a certain procedure, it is suspected that the chest will receive a higher exposure than the waist, the LiF TLD

shall be worn at chest level on the front of the body and secured so that the back of the holder remains against the body at all times. The wearer shall be instructed not to open the holder, as this might damage the LiF TLD card.

(c) Control LiF TLDs. Two control LiF TLDs, which must be from the same group as the issued LiF TLDs, shall be included with each submission. These control LiF TLDs are to be stored at the same location as the unissued LiF TLDs. The storage area should be of low and stable radiation background. The control LiF TLDs shall be listed first on the documents accompanying the submission and shall be documented for gamma and neutron evaluation.

(d) Collection. The LiF TLDs, in their holders, shall be mailed to the Radiological Safety Service, National Naval Medical Center, Bethesda, MD 20014, within three working days following collection. The dosimeters shall be arranged in the same order as they appear on the NAVMED 6470/3. The dosimeters and accompanying NAVMED 6470/3 shall be shipped in a mailing container, such as box NSN 8115-00-782-3939, (7 1/2 x 4 3/8") or box NSN 8115-00-782-3940 (7 1/2 x 7 x 3 3/8") that will prevent damage to the dosimeters. Because of the cost of the LiF TLD cards they shall be mailed using traceable means to prevent loss.

(4) Posted Environmental Dosimetry

(a) Neutron Environmental Dosimetry. Special procedures are required when posting the LiF TLD for environmental monitoring of neutron radiation or mixed fields of neutron and gamma radiation.

1. Use of a Phantom. As discussed previously, the LiF TLD requires a moderating medium, the body for personnel monitoring, or a phantom for environmental monitoring, to slow down and reflect incident neutrons into the dosimeter. The phantom to be used for environmental monitoring is a 6 inch by 6 inch by 3 inch block of plexiglass or polyethylene. The block may be made of smaller thicknesses laminated together to provide the required thickness.

2. Placement of the holder on the phantom. The back of a modified dosimeter holder, the belt loop having been removed, shall be mounted flush against the center of a 6 inch by 6 inch side of the phantom such that the front of the holder is away from the phantom. The method of mounting may be by rubber strap, cloth elastic strap, leather strap, or 1/4 inch to 1/2 inch wide tape which crosses over the center rib of the holder. The phantom shall be oriented so that the 6 inch by 6 inch side with the mounted dosimeter faces towards the direction of the expected source of radiation.

(b) Gamma Environmental Monitoring. Use of the LiF TLD for monitoring only environmental gamma radiation requires no special handling. Mounting of the dosimeter does not require the use of a phantom or any modification to the holder. However, the dosimeter should be oriented so that the front of the dosimeter faces in the general direction of the suspected source of radiation.

(c) Location of posted environmental dosimeters. The location of posted dosimeters for environmental monitoring shall not be changed without prior written approval from the commanding officer.

(5) Loading of LiF TLD holders. Activities will receive their LiF TLD cards preloaded in their holders. These holders shall not be opened. If a holder is accidently opened, then the LiF TLD card shall be checked for proper positioning in the following manner before closing the holder.

(a) Personnel Dosimeters. The LiF TLD card shall be positioned in the holder such that the notched corner aligns with the pin. This will place the LiF TLD chips (see figure 2) behind the cadmium filter. Close the holder, being careful to prevent the LiF TLD card from moving out of place.

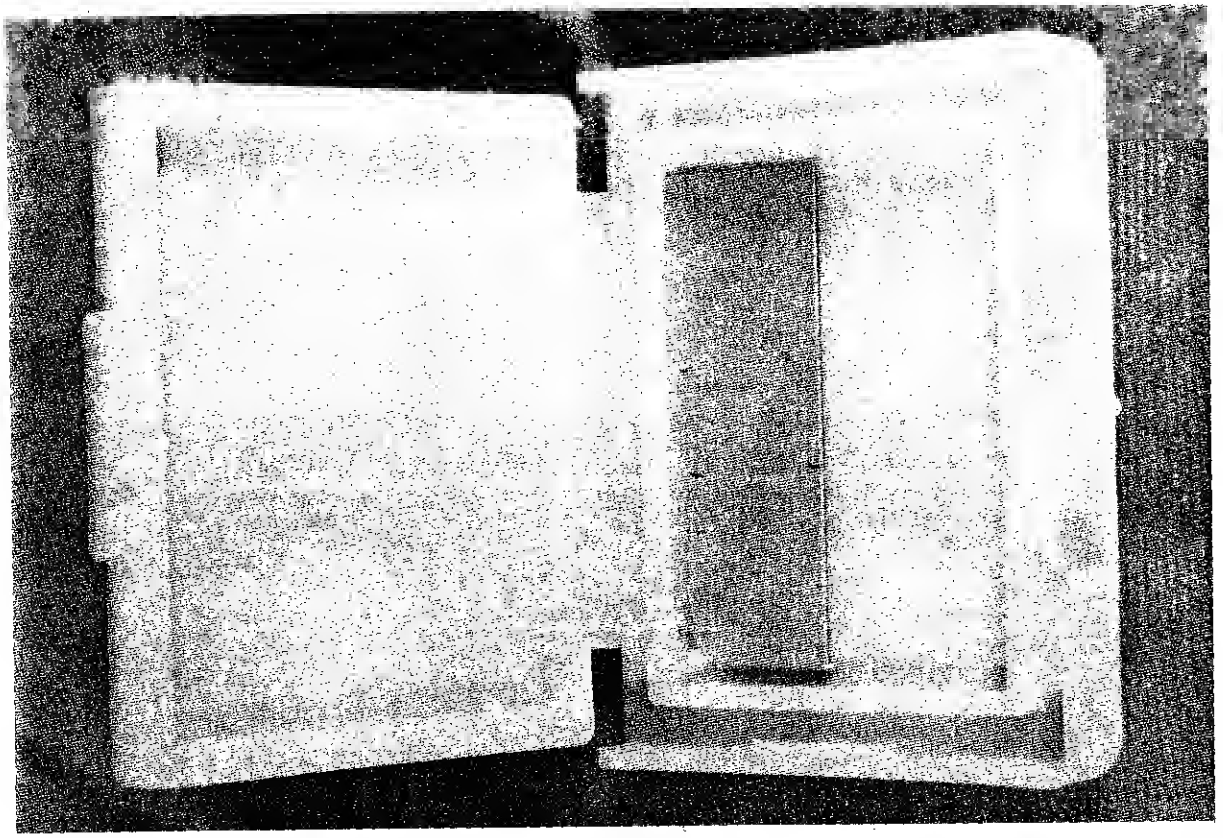
(b) Environmental Dosimeters. Environmental dosimeters used to monitor for neutrons contain two LiF TLD cards. The card listed first on the holder shall be loaded in the same manner as for personnel dosimeters (see above). The second card listed on the holder will be placed on top of the first card with both TLD chips lying to the side of the cadmium filter, not behind it. The gray side of the second card will be facing out. After both cards are positioned, the holder shall be closed carefully. Environmental dosimeters used to monitor for gamma radiation contain only one LiF TLD card loaded in the same manner as a personnel dosimeter.

(6) Documentation and Submission Requirements. Submission of LiF TLD dosimeters shall be made using the NAVMED 6470/3 form following the directions on the reverse side of the form. (Commands using the 57101 Computer Record Keeping System shall submit LiF TLDs in accordance with instructions received from BUMED). An original and one copy of NAVMED 6470/3 will be required with each submission of dosimeters. Following evaluation of the dosimeters the original will be returned to the submitting activity. The NAVMED 6470/3 shall be retained by the submitting activity for the current year and one subsequent year.

(a) Environmental LiF TLDs. Environmental dosimeters used for neutron monitoring shall be submitted in the following manner. The card listed first on the holder shall be listed with all the necessary information in columns 4, 6, 7, and 8. Column 4 shall indicate that the dosimeter was posted. The

card listed second on the holder will be listed on the next line of NAVMED 6470/3. Only column 6 needs to be filled out for this card. Dosimeters used for environmental gamma monitoring will be listed with all the necessary information in columns 4, 6, 7, and 8. Column 4 shall indicate that the dosimeter was posted.

Figure 1



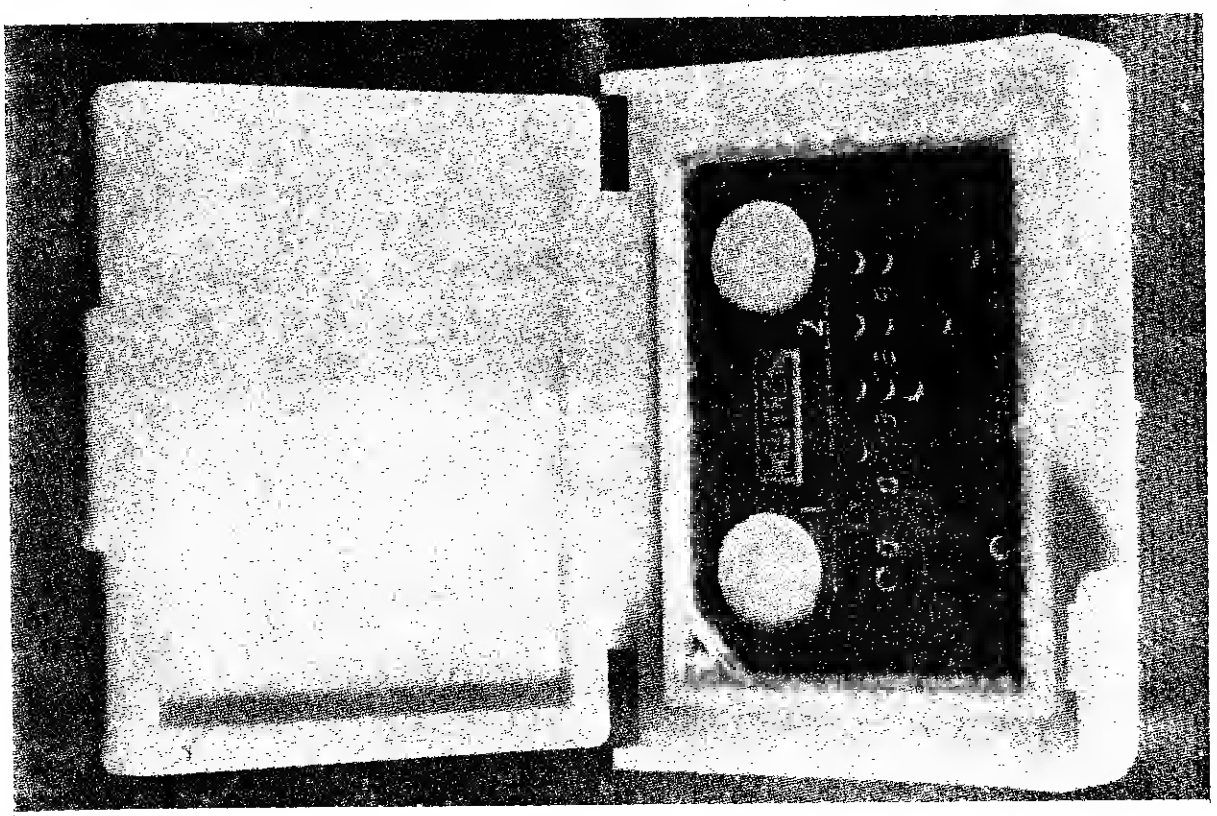


Figure 2

6-5. PHOTODOSIMETRY PROGRAM

(1) General Requirements. - Photodosimetry is an evaluating technique which utilizes photographic emulsions sensitive to ionizing radiation to determine an individual's exposure. Radiation passing through a grain of silver halide in the emulsion causes a change, resulting in the conversion of the grain to free silver when the film is developed. The silver causes a blackening of the emulsion which is measured as an increase in the optical density or as a darkened track of adjoining granules. With proper calibration, this darkening can be related to radiation exposures.

(a) Factors. To obtain accurate results, it is necessary to be consistent in all photodosimetric procedures. Among the many factors which affect film density are (1) emulsion type, (2) background density or base fog of the film, (3) type of film badge utilized, (4) type, concentration, age, and temperature of the developing solution, (5) development time, (6) amount of agitation during development, (7) fixing time, (8) accuracy of the densitometer, and (9) operator error.

(b) Density. To relate density to exposure, it is necessary to use a film calibration curve specifically developed for the type of film and radiation in question. Film calibration curves such as shown in Appendix C or the table shown in Appendix D shall be used for interpreting Kodak Type 3 film. Other variables must be controlled as follows:

1. Emulsion control film shall be used to subtract base fog in order to obtain a net density for evaluation.

2. Emulsion control film shall be kept in an environment where temperature and humidity factors are similar to those where films are being worn or exposed. Control film must not be exposed to radiation above natural background levels.

3. Kodak Type 3 film is extremely sensitive to x and gamma radiation. A gamma exposure of 4 mrem produces

a detectable increase in density. This film must not be stocked or stored near sources of radiation unless adequate shielding is provided.

4. All photographic film is subject to fogging by certain chemical vapors such as mercury, ammonia, or sulfur. Storage in areas where these vapors may exist must be avoided, especially after the stock package has been opened and the vapor seal broken.

5. Unopened packages of stock film should be stored at 35 to 50 degrees F. Opened packages should be stored at room temperature and humidity. Temperatures above 70 degrees F and humidity above 50% should be avoided wherever possible. If opened packages are returned to cold storage, the vapor seal must be secured to prevent the forming of condensation when the cold film packets are again removed from the cold storage. Wrapping in plastic alone is not adequate to secure the vapor seal.

6. The variation of film response with photon energy complicates the proper evaluation of exposure to energies below 0.2 MeV. For x and gamma rays of 0.2 MeV to 3 MeV, the film response is essentially constant. Below this range the variable response may require special evaluation (energy correction curves), except in a limited range of diagnostic x-ray energies for which calibration curves are provided by BUMED, Code 53 (See Appendix C).

7. Processing solutions will not be used to exhaustion.

6-6. STANDARD PHOTODOSIMETRY EQUIPMENT

(1) Photographic Emulsions

(a) Film Description and Availability. Film Radiac Pack, NSN 6665-00-935-4327, Kodak Type 3, shall be used for detecting x-ray, beta, and gamma radiation. Type 3 film is available from the following distribution points: (1) SUBASE, New London, CT: (2) NSC, Norfolk, VA; (3) NSC, Charleston, SC; (4) NSC, Oakland, CA; (5) NSC, Long Beach, CA; (6) NSC, San Diego, CA; (7) NSC, Pearl Harbor, HI; (8) NSC, Puget Sound, Bremerton, WA.

THERMOLUMINESCENT DOSIMETRY AUDIT PROCEDURES

Introduction

1. The transition, by forces afloat, from photodosimetry to thermoluminescent dosimetry for monitoring personnel exposure to ionizing radiation requires that the Medical Department Representative verify that the dose information is accurate. To accomplish this, the Medical Department Representative shall conduct an audit of the program in effect at his command once each quarter. Two of these quarterly audits are to be conducted in conjunction with the semi-annual radiation health program external audit required by NAVMED P-5055. The following audit procedures constitute a broad outline of procedural checks to be made. The list is not considered as restrictive and additional evaluations designed to promote and maintain a viable and effective monitoring program are encouraged.

THERMOLUMINESCENT DOSIMETRY AUDIT PROCEDURES

1. Identification:

a. Conduct a random check of a few (4 to 8) personnel to determine if they are, in fact, wearing the dosimeter that is recorded as having been issued to them.

b. Are dosimeters being worn properly?

c. Are dosimeters being issued to any unauthorized personnel?

d. Has the radiation physical examination, if required, of all personnel issued dosimeters been verified before the dosimeter was issued?

2. Issue and Collection:

a. Determine if the issue periods outlined in NAVSHIPS 389-0153 and NAVMED P-5055 for various categories of personnel, are being complied with.

b. Is monthly and quarterly exposure data from the DT-526/PD being forwarded to the Medical Department within five working days?

c. Have all personnel issued a dosimeter for administrative purposes been trained in accordance with article 208 of NAVSHIPS 389-0153 and has this training been documented?

d. Have all records pertaining to dosimeters been retained in accordance with NAVSHIPS 389-0153 and NAVMED P-5055?

3. Evaluation Technique (DT-526/PD only):

a. Are procedures outlined in NAVELEX 0967-456-6010 for calibration and operation of the CP-1112/PD being adhered to? Have unauthorized alterations or procedures been substituted?

b. Are the required calibration checks on the CP-1112/PD being accomplished at proper intervals during reading of the DT-526/PD dosimeters?

c. Has calibration of the DT-526/PD, as required by NAVSHIPS 389-0153, Article 233.4, been performed?

d. Verify that DT-526/PD calibration exposures using the TS-1189 source have been properly made.

4. Compilation and Transcription of Dose (DT-526/PD only)

a. Select the five personnel with the highest cumulative doses for the month from amongst those who have had daily dosimeter readings and audit their reported exposures with an adding machine.

b. Do exposures reported from the DT-526/PD dosimeter appear to be reasonable for the job performed by the man wearing the dosimeter? Previous exposure data reported for similar circumstances of work should provide a satisfactory guide for comparison.

c. Select several TLD record forms (figure 15A of NAVSHIPS 389-0153) at random and check for completeness.

d. Has the strip chart recorder been used for all readings?

e. Are the doses indicated on the TLD reader digital display being accurately recorded on worksheets?

5. Visitors:

a. Are current requirements for issuance of a visitor's dosimeter being complied with?

6. Lost/Damaged Dosimeters:

a. Have any dosimeters been lost or damaged during the preceding reporting period?

b. Are the requirements for estimation of dose in the case of lost or damaged dosimeters, as outlined in NAVMED P-5055, being complied with?